Intranational and International Consumption Risk Sharing and Frictions in China*

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Abstract

This paper applies the gravity model to estimate the level of intra-national and international consumption risk sharing, financial frictions and trade frictions across Chinese provinces in 2002 and 2007. We measure the risk sharing and financial frictions based on the volatility of the relative Pareto Weights. We find that both intra-national and international risk sharing levels are limited since the relative Pareto weights varies heterogeneously from 2002 to 2007 across provinces. Second, we show the relative intra-national Pareto weights change less than the relative international Pareto weights for most of the provinces, implying that the intra-national risk sharing is higher than the international risk sharing for most of the provinces or most provinces face additional financial frictions in hedging international risks than in diversify intranational risks. Third, we also find that richer provinces have higher real exchange rate in both 2002

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and 2007 (the Balassa Samuelson effect holds cross-sectionally in China), and that the relative consumption per capita growth is negatively correlated with the changes of the relative real exchange rate (the Backus-Smith condition holds). Last not the least, we estimate decreasing intra-national and international trade costs measured by the distance ranges from 2002 to 2007.

Keywords: Financial Frictions; Gravity Equations; Risk Sharing; Trade Costs

JEL classification: F41, F14

1 Introduction

Both intra-national and international goods and asset markets can help countries and regions achieve an efficient consumption allocation, which implies an equalization of marginal utility growth among countries, once corrected for possible fluctuations in the real exchange rate (RER) as in Backus and Smith (1993). For any two regions/countries i and j, their relative marginal utility of aggregate consumption, $u^i_{c_t}/u^j_{c_t}$, should satisfy the following condition,

$$\frac{u^i_{c_t}}{u^j_{c_t}}\frac{P^j_t}{P^i_t} = \left(\frac{\lambda^i_t}{\lambda^j_t}\right)^{-1} \tag{1.1}$$

where $P^j_t/P^i_t = RER$ is defined as the real exchange rate in terms of country i's price index, and $\left(\frac{\lambda^i_t}{\lambda^j_t}\right)$ is the relative Pareto weight that a social planner assigns to regions. The Pareto weight, λ^i_t, is equal to the inverse of the marginal utility of nominal wealth in the decentralized optimization problem. An efficient consumption allocation with complete financial markets (allowing goods market frictions or not) requires a constant relative marginal utility weighted by RER, or a constant relative Pareto weight (λ^i/λ^k). With frictions in asset markets, regions cannot fully hedge income risks and RER risks. The relative pareto weights need not be constant.[1] Estimating and examining the volatility of the Pareto weights provide a natural way to measure the extent of the financial frictions and the level of risk sharing.

The literature mostly studies the risk sharing based on the above aggregate consumption behaviors and cannot estimate the λs from (1.1). As pointed out by Cole and Obstfeld (1991), an optimal consumption risk sharing assuming complete markets and frictionless goods markets also implies a constant ratio of marginal utilities from consuming any good across states of nature among regions. Like (1.1), the efficient allo-

[1] Cole and Obstfeld (1991) assume homogeneous preference and frictionless goods markets and find that countries attain optimal risk sharing even under financial autarky. The interactions among heterogeneous preferences, frictions in goods and financial markets are essential for risk sharing.

cation on any good k (produced in region/country k) by the two regions i and j should satisfy the following condition given the relative time-varying iceberg trade costs, $\frac{\tau_t^{jk}}{\tau_t^{ik}}$, paid by imports,

$$\frac{u^i_{k_t}}{u^j_{k_t}} \frac{\tau_t^{jk}}{\tau_t^{ik}} = \left(\frac{\lambda_t^i}{\lambda_t^j} \right)^{-1}. \tag{1.2}$$

With frictionless asset markets and goods market frictions, efficient risk sharing still implies a constant λ^j/λ^i, but a fluctuating $u^i_{k_t}/u^j_{k_t}$ because of the changes in trade costs. With frictions in both goods and financial assets, both $u^i_{k_t}/u^j_{k_t}$ and λ_t^j/λ_t^i becomes volatile because they are influenced by the changes of trade costs in goods markets, financial frictions, preference differences, income/output risks and other shocks in the economy.

This paper extends Fitzgerald (2012) and Guo (2015) to focus on each components of the consumption basket based on 1.2 and study the intra-national and international consumption risk sharing across Chinese provinces at years 2002 and 2007. We find that the provinces use both intra-national and international goods and financial markets to hedge their consumption risks and risk sharing is limited. Second, the level of international risk sharing is higher than that of the intra-national risk sharing. Third, both the relative intra-national trade costs and the relative international trade costs measured by distance decrease significantly from 2002 to 2007. To our knowledge, this is the first paper to analyze both intranational and international risk sharing in China along with financial frictions and trade costs.

The structure of the paper is as follows. Section 2 derives the theoretical gravity model based on Anderson and Van Wincoop (2003). Section 3 provides a empirical framework to estimate frictions and risk sharing. Section 4 presents the empirical results on risk sharing and trade costs in China. The last section concludes.

2 Theoretical Model

2.1 Production, Preference, and Frictions

I combine Backus and Smith (1993)'s stochastic economy with production with Anderson and Van Wincoop (2003) to derive a structural gravity equation like Fitzgerald (2012) and Guo (2015). There are $N+1$ countries(regions) in the world, where they are indexed $i = 1, ..., N, N+1$, and the last country (China) has J regions, indexed $i = 1, ..., J$. Each region represented by a single agent who produces, trades goods with other regions, consumes and lives from date 0 to infinite. At each date t ($t \in 1, 2, ...$), the economy experiences one event, s_t, drawn from a finite the state space; and s^t is defined as the history of events, $s^t \equiv (s_1, s_2, ..., s_t)$ at date t, an element of the finite set S^t. The history, in addition to the initial event s_0, completely describes the state of the economy at date t. The probability of any state s^t, given s_0, is denoted$\pi(s^t)$. The following sections omit the history s^t in variables unless it is necessary. Each region stochastically produces a distinct tradeable final good (indexed as i for region i) only using labor. The final good i in region i at time t is produced with labor L_t^i and a realized productivity A_t^i: [2]

$$Y_t^i = F\left(A_t^i, L_t^i\right) \tag{2.1}$$

The productivity A_t^i follows a stochastic process.

Region i is inhabited by a single agent whose expected utility is described by:

$$U^i = \sum_{t=0}^{\infty}\sum_{s^t}\beta^t \pi_t N_t^i u\left(\frac{C_t^i}{N_t^i}\right) \tag{2.2}$$

[2]Introducing capital to the production process still derive the same gravity model on bilateral imports.

where N_t^i is the population, and π_t is the probability of history s^t at time t. The consumption level C_t^i comes from a CES aggregator on $N+J$ goods as follows:

$$C_t^i = \left(\sum_{k=1}^{N+J} \left(Z_t^{ik} \right)^{\frac{\eta-1}{\eta}} \right)^{\frac{\eta}{\eta-1}}$$

where $\eta\,(>0)$ is the elasticity of substitution between goods, and Z_t^{ik} is the quantity of imports in country i from country k at history s^t (Z_t^{ii} is the domestic absorption).

In the empirical part, I assume a constant relative risk averse utility function,

$$u\left(c_t^i\right) = \frac{\left(c_t^i\right)^{1-\rho}}{1-\rho} \tag{2.3}$$

where $\frac{1}{\rho}\,(>0)$ is the intertemporal elasticity of substitution and the small letter c_t^i is per capita consumption.

The region i faces the following budget constraint:[3]

$$\begin{aligned} E_t^i \equiv \sum_{k=1}^{N+J} Q_t^{ik} Z_t^{ik} \equiv P_t^i C_t^i \\ = Q_t^{ii} Y_t^i + \left[\mathbf{D}_t + \mathbf{R}_t\right] \mathbf{B}_t^i \left(s^{t-1}\right) - \mathbf{R}_t \mathbf{B}_{t+1}^i \left(s^t\right) \end{aligned} \tag{2.4}$$

where P_t^i is the spot price for the aggregate consumption in region i, and Q_t^{ik} is the spot price for the import good k in region i (produced in region k). The first line represents the total (household) consumption expenditure of region i, at time t, on $N+J-1$ imports and her domestic good i, E_t^i. The second line is the total output/income from the good production $O_t^i = Q_t^{ii} Y_t^i$ and net asset holdings. Region i holds a vector of assets $\mathbf{B}_t^i\left(s^{t-1}\right)$ from last period $t-1$, and receives dividends $\mathbf{D}_t$ this period t. The

[3]All regions price their goods based on a world currency; nominal exchange rate is not involved here. In the empirical part, imports, consumptions and outputs are all measured in the current US dollar.

income from asset holdings is $\left[\mathbf{D}_t + \mathbf{R}_t\right]\mathbf{B}_t^i\left(s^{t-1}\right)$, where $\mathbf{R}_t$ is the asset price vector. Then the country re-optimizes asset holdings to a new level $\mathbf{B}_{t+1}^i\left(s^t\right)$ this period.

Intra-national goods markets in China and International goods markets are assumed to have iceberg trade costs τ_t^{ik} with $\tau_t^{ii} = 1$, $\tau_t^{ik} \geq 1$ and $\tau_t^{ij}\tau_t^{jk} \geq \tau_t^{ik}$ $(j \subseteq N)$ a la Obstfeld and Rogoff (2000) and others. These transaction costs τ_t^{ik} are paid using import good k by region i. Therefore, prices of imports differ across countries:

$$Q_t^{ik} = \tau_t^{ik} Q_t^{kk} = \tau_t^{ik} Q_t^k \tag{2.5}$$

where Q_t^k (Q_t^{ik}) is the spot prices of final good k in home county k (importer i). Consequently, the final goods resource constraints must take trade costs into account, and the market clearing condition for good k produced in region k at time t is:

$$Y_t^k = \sum_{i=1}^{N+J} \tau_t^{ik} Z_t^{ik} \tag{2.6}$$

Accordingly, the market clearing conditions for assets require zero net supply:

$$\sum_{i=1}^{N+J} \mathbf{B}_{t+1}^i\left(s^t\right) = 0$$

Asset markets within each region are assumed to be perfect/frictionless, but the intra-national financial markets in China and international asset markets are incomplete and have frictions. For example, we can assume that only bonds can be traded across regions with a credit/borrowing constraint. The tightness of credit conditions can differ across regions. As long as the financial frictions do not change the first order condition of the aggregate consumption as 1.1, we can derive the same equilibrium condition or the gravity model for bilateral imports.[4] So we can assume general asset

[4] If we model capital accumulation in the production, equity can also be traded across regions. The equilibrium condition or the gravity model for bilateral imports remain.

market frictions, and does not specify a detailed asset structure like Fitzgerald (2012). The paper does not solve the equilibrium for bilateral asset holdings, but focuses on equilibrium conditions on the consumption goods only.

2.2 The First Order Conditions

A general equilibrium is defined as the set of quantities and prices, $\{\mathbf{Z}^*$, $\mathbf{L}^*$, $\mathbf{Y}^*$, $\mathbf{B}^*$, $\mathbf{D}^*$, $\mathbf{Q}^*$, $\mathbf{R}^*\}$, such that firms choose prices to maximize profits, the represent agents maximize utilities subject to the budget constraints, and all markets clear. The first order conditions with respect to aggregate consumption and each import are necessary to obtain the equilibrium — 1) a monopolistic firm in each country maximizes the profit to choose the price Q_t^i, labor demands L_{td}^i, outputs Y_t^i, and dividends D_t^i; 2) a representative agent maximizes the utility by choosing home good and imports $Z_t^i(k)$, labor supplies N_{ts}^i, and asset holdings $\mathbf{B}_{t+1}^i$; 3) market clearing conditions hold for labors, all goods and assets ($i = 1, ..., N + J$).

The first order condition (FOC) with respect to the aggregate consumption C_t^i is:

$$\lambda_t^i \left(C_t^i/N_t^i\right)^{-\rho} = P_t^i \tag{2.7a}$$

where $1/\lambda_t^i$ is the lagrange multiplier of the budget constraint/the marginal utility of current per capita (nominal) wealth for region i at time t, and $u_c(.)$ is the marginal utility of consumption per capita. λ_t^i also represents the Pareto weight for region i at time t in a world social planner problem such that $\sum_{i=1}^{N} \lambda_t^i = 1$. The social planner signs the weight to each country each period. With perfect international and intra-national asset markets, regions achieve complete risk sharing, and the Pareto weight for each region is constant over time. When regions cannot perfectly share risks due to financial frictions, the Pareto weights change over time. As a result, testing the volatilities of the Pareto weights λ_t^i is the key to test the significance of financial frictions. We also derive the FOC in terms of the value of consumption,

$$\left(\lambda_t^i\right)^{\frac{1}{1-\rho}} \left[P_t^i c_t^i\right]^{\frac{-\rho}{1-\rho}} = P_t^i \tag{2.7b}$$

The CES demand function for any final good k in region i (imports), IM_t^{ik}, gives the gravity model,

$$IM_t^{ik} \equiv Q_t^{ik} Z_t^{ik} = \left(\frac{P_t^i}{Q_t^k \tau_t^{ik}}\right)^{\eta-1} \left(P_t^i C_t^i\right) \tag{2.8}$$

Correspondingly, the aggregate price index P_t^i can be derived as,

$$P_t^i = \left[\sum_{k=1}^{N+J} \left(\tau_t^{ik} Q_t^k\right)^{1-\eta}\right]^{\frac{1}{1-\eta}} \tag{2.9}$$

2.3 Gravity Equation

With the resource constraint of each good (2.6) and the demand function (2.8), I get the gravity equation:

$$\frac{IM_t^{ik}}{E_t^i * O_t^k} = \left(\frac{P_t^i \Pi_t^k}{\tau_t^{ik}}\right)^{\eta-1} \tag{2.10a}$$

$$= \left(\frac{\left(\lambda_t^i\right)^{\frac{1}{1-\rho}} \left[P_t^i c_t^i\right]^{\frac{-\rho}{1-\rho}} \Pi_t^k}{\tau_t^{ik}}\right)^{\eta-1} \tag{2.10b}$$

$$\widetilde{\lambda_t^i} = \lambda_t^i / \left(\sum_{j=1}^{N} \lambda_t^j\right)$$

where the import value of country i from country k is IM_t^{ik} $\left(= \tau_t^{ik} Q_t\left(k\right) Z_t^i\left(k\right)\right)$; the value of country i's total expenditure is E_t^i $\left(= P_t^i C_t^i\right)$; the value of country k's output is O_t^k $\left(= Q_t\left(k\right) Y_t^k\right)$. The time-varying multilateral resistance Π_t^k is the weighted expenditure share of each country in the world,

$$\left(\Pi_t^k\right)^{1-\eta} = \sum_{j=1}^{N} \left(\frac{P_t^j}{\tau_t^{jk}}\right)^{\eta-1} E_t^j \tag{2.11}$$

Substituting equation (2.7b), we can get another version of the gravity model (2.10b) with the Pareto weight.

3 Equation to Test Risk Sharing

Now, we derive the empirical gravity model to estimate the financial frictions and trade costs. Taking logs of the gravity equation (2.10b) yields the baseline estimation equation,

$$w_t^{ik} = cons + \theta_t^i \left(\equiv \widetilde{\theta}_t^i + \beta_c lc_t^i\right) + \phi_t^k + \sum_{j=1}^{9} \gamma_{jt} g_j^{ik} + +\varepsilon_t^{ik} \tag{3.1}$$

where the dependent variable w_t^{ik} is the log of the bilateral import ratio, defined as:

$$w_t^{ik} \equiv log\left(\frac{IM_t^{ik}}{E_t^i * O_t^k}\right)$$

Regressors include the constant *cons*, the log of the share weights $\delta^{ik} \equiv log(\alpha^{ik})$, the log of Pareto weights $\widetilde{\theta}_t^i \equiv \frac{\eta-1}{1-\rho} log(\widetilde{\lambda}_t^i)$, the log of per capita consumption in term of dollar value $lc_t^i \equiv log\left(P_t^i c_t^i\right)$, the log of employment rate $ll_t^i \equiv log\left(l_t^i\right)$, the multilateral resistance terms $\phi_t^k \equiv (\eta-1)log(\Pi_t^k)$ and bilateral trade costs g_j^{ik}. Like Anderson and Van Wincoop (2004) and Waugh (2010), bilateral trade costs take the form as follows,

$$log[\left(\tau_t^{ik}\right)^{1-\eta}] \equiv \sum_{j=1}^{9} \gamma_{jt} g_j^{ik} + f_{kt} + f_{kt} * China_{ik} \tag{3.2}$$

where $g_j^{ik}(\equiv log\left(G_j^{ik}\right))$, includes the eight dummy variables of bilateral distance ranges, one dummy variables for country border and (potential) asymmetric fixed export costs in domestic and international goods markets. The indicator $China_{ik}$ takes one if the importer and exporter are both in China, otherwise zero.

We estimating a time-varying $\widetilde{\theta}_t^i$ and γ_{jt} from (3.1) year-by-year in two cases: within China and across border with all regions. The former case estimates intra-national risk sharing and frictions on domestic goods and asset markets, and the later one estimates heterogeneous frictions in both intra-national and international goods and financial markets. The importer-year fixed effect θ_t^i contains two parts: the Pareto weights $\widetilde{\theta}_t^i$ and the per capita consumption $\beta_c lc_t^i$; i.e. $\theta_t^i = \widetilde{\theta}_t^i + \beta_c lc_t^i$. A constant relative $\widetilde{\theta}^i$ represents the condition of the efficient risk sharing or the special case of frictionless asset markets, where the relative normalized Pareto weights $\widetilde{\lambda}^i$ should be heterogeneous across countries but constant over time. A constant relative γ_j is regarded as the case with constant trade costs.

We collect manufactural trade data and output data (valued in the current US dollar) for 30 regions in China and 70 trade partners at years 2002 and 2007. Bilateral trade data within China are from the Input-Output data constructed by Shantong Li (2005) and Chinese Social Science. The trade data between Chinese regions and foreign countries are from Feenstra et al. (2009). The trade data across 70 countries are from UNCOMTRADE. Manufactural output are mainly from UNIDO and the missing values are based on the manufactural value added data from World Bank's World Development Indicators. Data on the household expenditure and consumption are from Chinese Statistics Year book for Chinese provinces and World Bank's World Development Indicators for other 70 countries.

4 Estimation Results

We estimate the gravity model with the trade data only within China and then obtain the relative real exchange rate relative (RRER) and trade costs within China, where Shanghai has the highest GDP per capita and is the base region. Based on the within-China RRER, we can calculate the intranational Pareto weights (risk sharing/financial frictions) assuming reasonable parameters on the elasticity of substitution across goods and the intertemporal elasticity of substitution. Alternatively, with data on all 100 regions we get the (international) RRER, the relative international Pareto weights and trade costs in the world markets. The two-year panel allows us to discuss the changes in the RRER, the relative Pareto weights, risk sharing levels and trade costs across provinces in both intranational and international scenarios.

4.1 Relative Real Exchange Rate, Income and Consumption

First, we discuss the relationships between the RRER and income/consumption based on the estimations with 100 regions, respectively. From

$$RRER_t^i \equiv \frac{RER_t^i}{RER_t^{Shanghai}} = exp\left(\frac{\theta_t^i - \theta_t^{Shanghai}}{\eta - 1}\right)$$

, we know that the RRER is positively related with the relative θ given the elasticity of substitution between goods is larger than one ($\eta > 1$). We assume $\eta = 2$ and calculate the log of the RRER for each province in each year. Figure 1 shows that provinces with higher income levels (GDP per capita) have higher relative real exchange rates (living standards) in both 2002 and 2007; the correlation coefficients are 0.771 and 0.85, respectively. This implies that the Balassa-Samuelson effect holds across provinces in China.

Then we calculate the changes of the log of RRER from 2002 to 2007 and find that the relationship between the changes of the log of RRER and the relative per capita consumption growth is U-shaped in Figure 2. Excluding three provinces (Zhejiang, Jiangsu and Guangdong), the changes of the RRER estimated from the within China case is negatively related with the relative consumption growth (-0.133). Excluding Zhejiang and Jiangsu, the changes of the RRER estimated from the case with 100 regions is negatively related with the relative consumption growth (-0.139). These results are consistent to the findings in Hess and Shin (2010), who show that the the Backus-Smith condition holds if they control for the volatility of the nominal exchange rate. They also find that the Backus-Smith condition holds across states within the USA, similar to our case within China.

4.2 Volatile Pareto Weights

Now we discuss how the relative changes in $\widetilde{\theta_t^i}$ ($= \frac{1-\rho}{\eta-1} log(\lambda_t^i)$) are related to the changes in the relative log of consumption per capita from 2002 to 2007. Given relative smoothing consumption growths across regions, efficient risk sharing requires a relative constant $\widetilde{\theta_t^i}$ and a convergence in the changes of $\widetilde{\theta_t^i}$. A volatile $\widetilde{\theta_t^i}$ can generate time-varying Pareto weights, which indicates the existence of financial frictions and limited risk sharing. The more changes in $\widetilde{\theta_t^i}$, the less risk sharing and the more financial frictions the region has. Table 1 shows the dispersion of the changes in $\widetilde{\theta_t^i}$ and log of consumption per capita in 30 Chinese regions. The $\widetilde{\theta_t^i}$ growth is much more diverse compared with the consumption growth. In particularly, the $\widetilde{\theta_t^i}$ in the intra-national case has the largest dispersion, implying that intra-national risk sharing is more limited compared with international risk sharing and international markets do help regions to hedge consumption risks. Figure 1 shows that there is a positive relationship between the relative changes of $\widetilde{\theta_t^i}$ and log of consumption per capita, and relationship is more outstanding for the intra-national case. Regions adjust their consumption more since they face more intranational financial frictions (a larger changes in $\widetilde{\theta}_t^i$).

Next we assume reasonable parameter values to calculate the relative Pareto weight for each region in China (Shanghai is the base) given by,

$$\widetilde{\lambda}_t^i = \frac{exp\left[\left(\frac{1-\rho}{\eta-1}\right)\theta_t^i + \rho lc_t^i\right]}{exp\left[\left(\frac{1-\rho}{\eta-1}\right)\theta_t^{Shanghai} + \rho lc_t^{Shanghai}\right]}.$$

According to the international macro literature, we assuming $\rho = 1.5$ and $\eta = 2$. Figures 3 and 4 present the relative intranational and international Pareto weights in both 2002 and 2007. An efficient risk sharing implies that the relative Pareto weights of these regions in both years should be same and on the 45 degree line; the actual value, however, are far away from the 45 degree line. The fitted line for both intra-national and international cases are above the 45 degree lines. We infer that both the intra-national and international risk sharing is limited based on the significance changes in $\widetilde{\theta}_t^i$ and very smoothed consumption.

We also find that the relative Pareto weights in the intra-national case have a lower mean and standard deviation than those in the international case (.047 vs 0.096). The less volatility and dispersion of the relative Pareto weights, the higher risk sharing levels. Most of the provinces in Figure 5 have more changes in the international Pareto weights, implying that most provinces faces more financial frictions in hedging the international risks. Figure 6 shows that provinces with higher GDP growth have larger absolute changes in the relative Pareto weights and lower risk sharing, Second, we also find that the the international financial frictions are higher than the intranational financial frictions because .

4.3 Decreasing Trade Costs

Since the trade costs measured by the border dummy do not change significantly from 2002 to 2007, we focus the changes in aggregate trade costs measured by the distance from the following definition,

$$log\widehat{\left(\tau_{2007}^{ik}\right)}^{1-\eta} - log\widehat{\left(\tau_{2002}^{ik}\right)}^{1-\eta} = \sum_{j=1}^{8}\widehat{\gamma_{j2007}}g_j^{ik} - \sum_{j=1}^{8}\widehat{\gamma_{j2002}}g_j^{ik},$$

. Table 2 shows the results for the relative intranational, international and overall trade costs; the base region is Shanghai. All three relative trade costs are decreasing significantly and the changes in the trade costs slightly show an inverse U trend. The only exception if the range [2400, 4800) in the intranational case, the relative trade costs are increasing but insignificantly. The large decreases of the overall trade costs in both intranational and international goods markets are mainly due to the large drops in the international goods markets. Results on the large decreasing international and overall trade costs remain if we assuming that effects of distances on imports are asymmetric in the intranational and international goods markets or no asymmetric fixed exporting costs.

5 Conclusion

This study shows the significance of financial market frictions in determining trade flows and risk sharing among 100 regions and countries in 2002 and 2007. Particularly, we are interested in the intranational and international risk sharing levels across 30 regions in China. Borrowing the gravity model from the trade literature, we test and estimate the financial frictions, risk sharing and trade costs based on the element/import in the aggregate consumption basket for each region. This approach is different from the traditional risk sharing test and can estimate both financial frictions and trade costs simultaneously. We find that both the intranational and international risk sharing of the Chinese regions is quite limited. We also support that the international goods and financial markets are important to the consumption risk sharing in China based on the result that international risk sharing is lower than the intranational one for most of the provinces. This may be due to more international financial frictions that each provinces faces in sharing the international risks. Finally, we provide the evidence to support the Balassa-Samuelson effect and Backus-Smith condition across provinces within China.

References

J.E. Anderson and E. Van Wincoop. Gravity with gravitas: a solution to the border puzzle. *American Economic Review*, 93(1):170–192, 2003.

J.E. Anderson and E. Van Wincoop. Trade costs. *Journal of Economic literature*, 42 (3):691–751, 2004.

D.K. Backus and G.W. Smith. Consumption and real exchange rates in dynamic economies with non-traded goods. *Journal of International Economics*, 35(3-4):297–316, November 1993.

Harold L. Cole and Maurice Obstfeld. Commodity trade and international risk sharing : How much do financial markets matter? *Journal of Monetary Economics*, 28(1):3–24, August 1991. URL `http://ideas.repec.org/a/eee/moneco/v28y1991i1p3-24.html`.

R.C. Feenstra, H. Deng, C. Hong, A. Ma, H. Ma, and S. Yao. Chinese and Hong Kong International Trade Data (For Use at UC Davis). *Institute of Governmental Affairs University of California, Davis*, 2009.

D. Fitzgerald. Trade costs, asset market frictions and risk sharing. *American Economic Review*, 102(6):2700–2733, September 2012.

Meixin Guo. Estimating international consumption risk sharing and financial frictions with gravity equation. *Tsinghua University. Manuscript*, June 2015.

Gregory D. Hess and Kwanho Shin. Understanding the backussmith puzzle: It's the (nominal) exchange rate, stupid. *Journal of International Money and Finance*, 29(1):169 – 180, 2010. ISSN 0261-5606. doi: http://dx.doi.org/10.1016/j.jimonfin.2009.07.005.

M. Obstfeld and K. Rogoff. The six major puzzles in international macroeconomics: is there a common cause? *NBER macroeconomics annual*, pages 339–390, 2000.

Michael E. Waugh. International trade and income differences. *American Economic Review*, 100(5):2093–2124, 2010. doi: 10.1257/aer.100.5.2093. URL `http://www.aeaweb.org/articles.php?doi=10.1257/aer.100.5.2093`.

Table 1: Changes in $\widetilde{\theta_t^i}$ and consumption from 2002 to 2007

Variable	Obs	Mean	Std. Dev.	Min	Max
$\triangle\widetilde{\theta_t^i}$intra	30	-0.855	0.639	-3.374	0.283
$\triangle\widetilde{\theta_t^i}$overall	30	-0.729	0.463	-2.077	0.005
$\triangle rlc$	30	-0.034	0.078	-0.199	0.111
$\triangle lc$	30	0.474	0.078	0.309	0.619

△ refers to the change. *rlc* or *lc* is the relative/absolute log of consumption per capita.

Table 2: Changes in trade costs from 2002 to 2007 for three cases

Dist.(miles)	△Intra	△no-intra and inter only	△overall
0-150	0.111	1.118**	1.115**
150-300	0.288	1.103	1.167*
300-600	0.686***	1.451***	1.586***
600-1200	0.716***	1.172***	1.392***
1200-2400	0.366*	1.175***	1.259***
2400-4800	-0.261	1.070***	1.143***
4800-9600	-	1.120***	1.221***
¿9600	-	1.119***	1.221**

△Intra (△Inter or △overall) is the changes in the coefficients of the intra-national (international or overall) trade costs measured by the distance from 2002 to 2007. The "intra" case uses the domestic bilateral import data across 30 provinces only. The case of "no-intra and inter only" estimates the gravity model without intranational bilateral trade data. The "overall" case uses bilateral data on all 100 regions. Positive values represent decreasing trade barriers measured by distance. *** significant at 1%; ** significant at 5 %; * significant at 10% based on robust standard deviations.

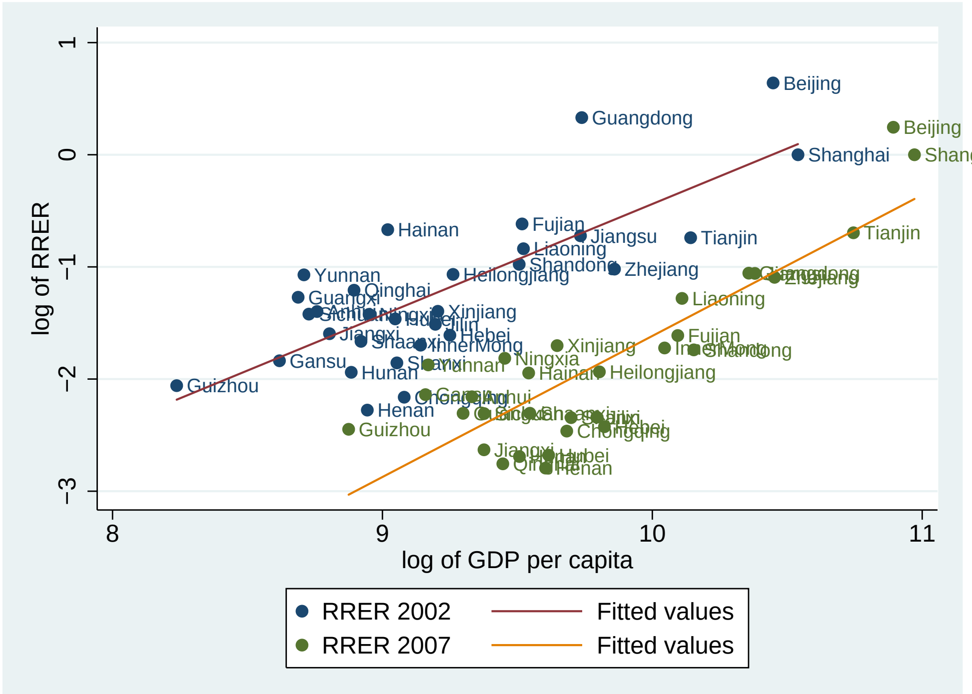

Figure 1: The Balassa-Samuelson effect within China, 2002 and 2007

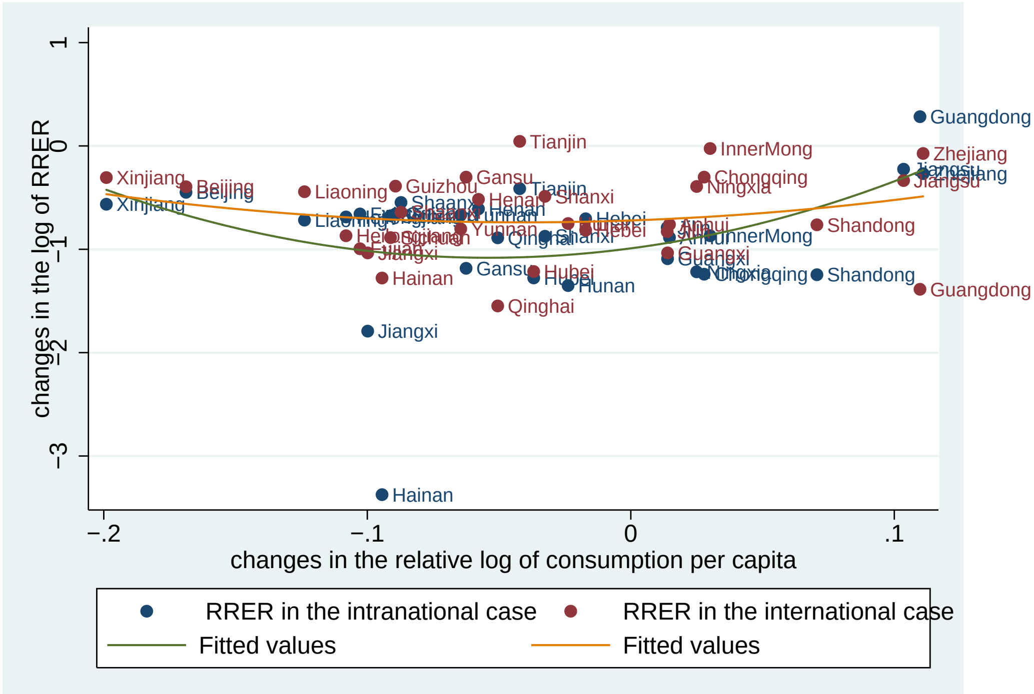

Figure 2: The Backus-Smith condition from 2002 to 2007

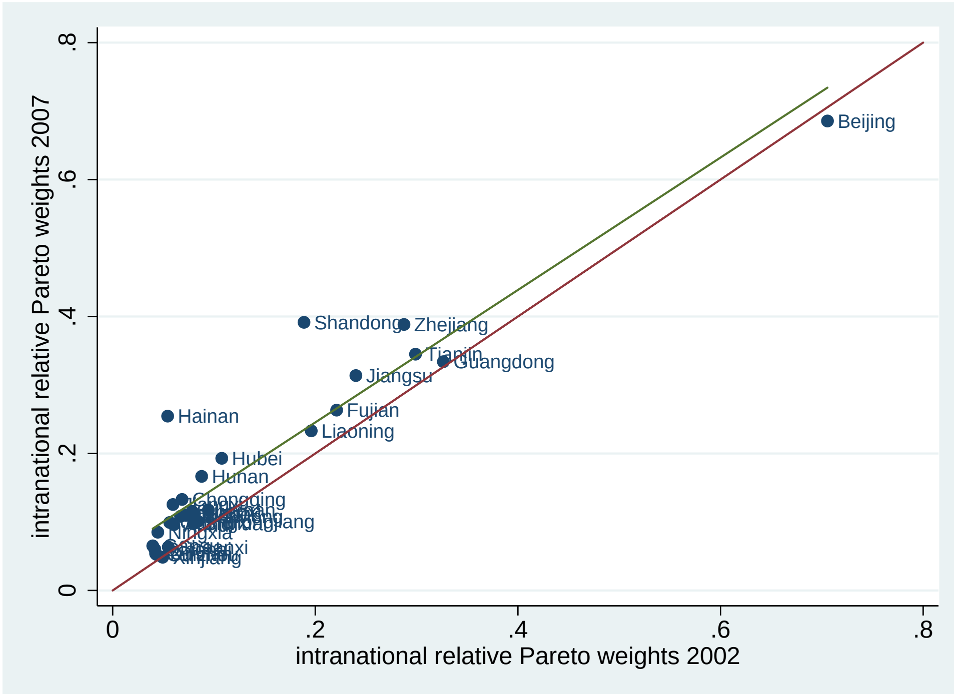

Figure 3: Relative intranational Pareto weights across provinces from 2002 to 2007

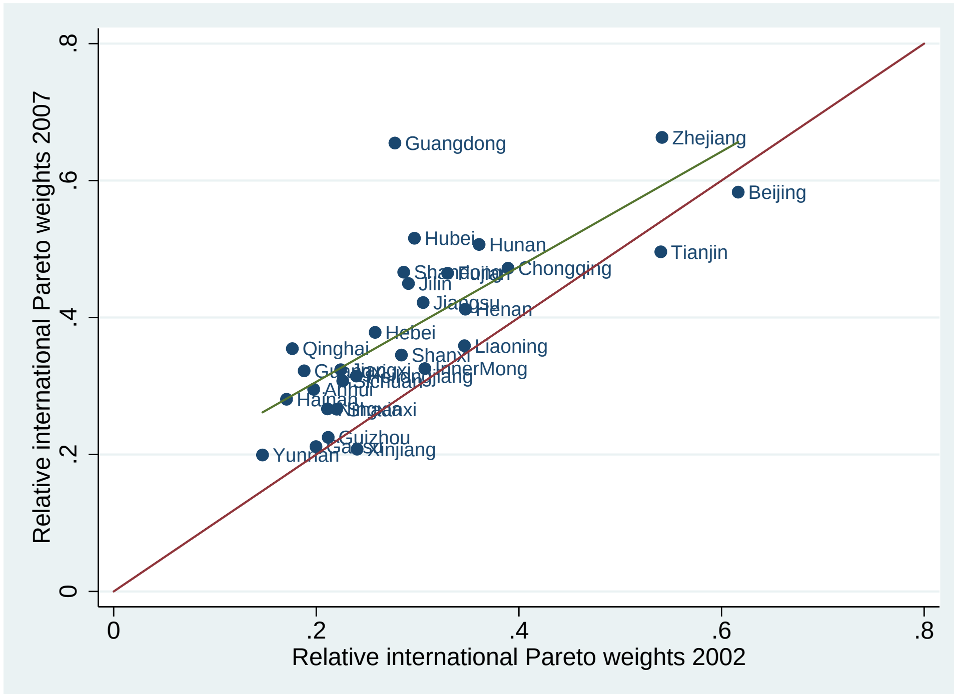

Figure 4: Relative international Pareto weights across provinces from 2002 to 2007

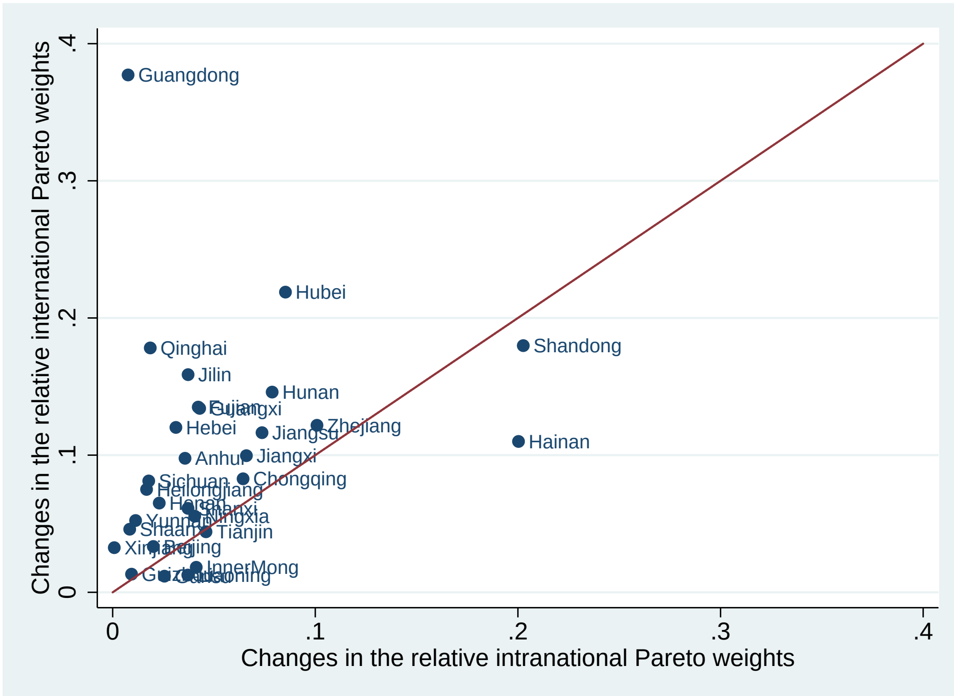

Figure 5: Intranational and international risk sharing (financial frictions) across provinces

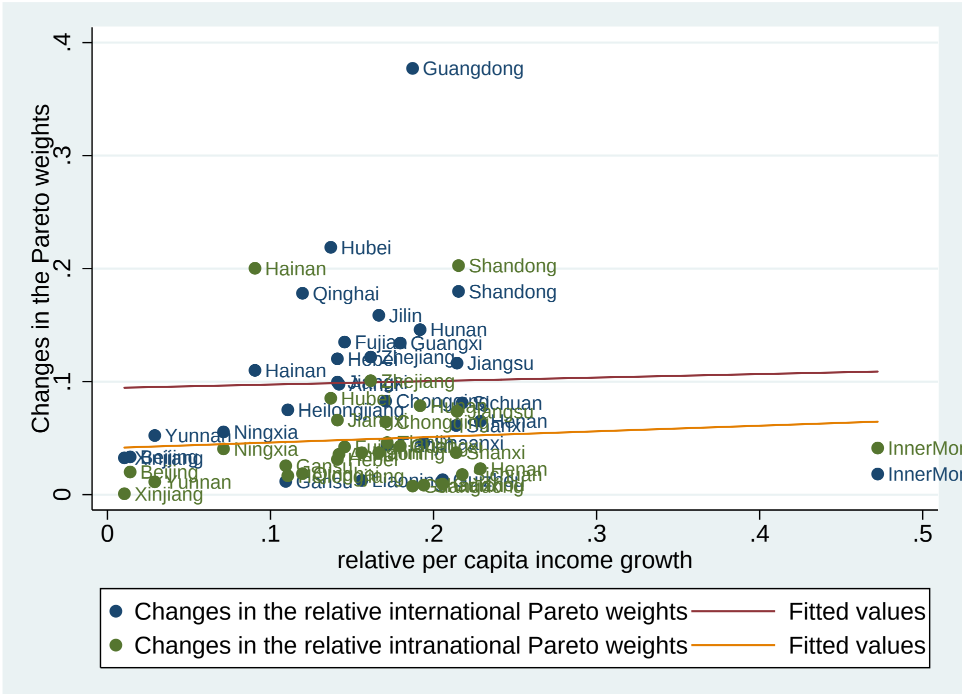

Figure 6: Variations of Pareto weights/risk sharing and the relative per capita income growth across provinces